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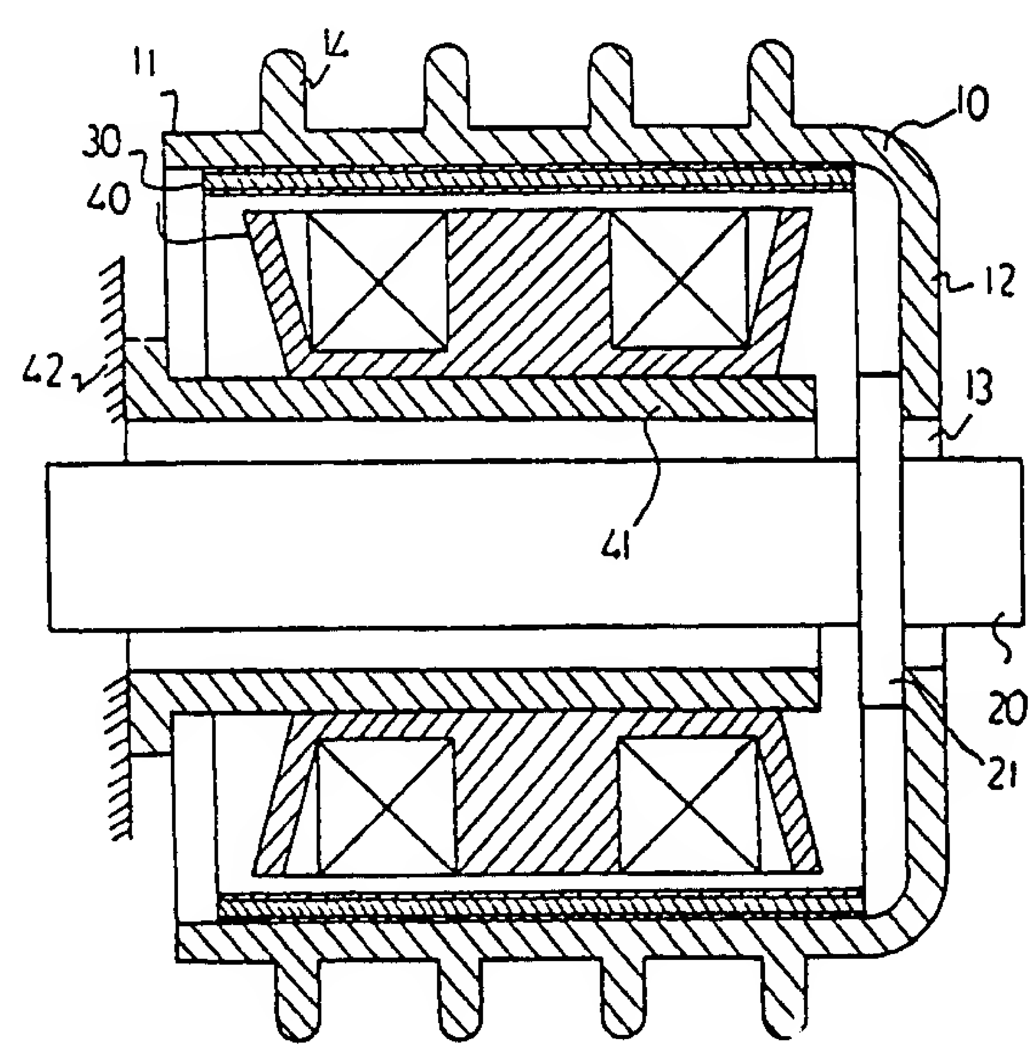
(54) ## EDDY CURRENT BRAKE.

(57) A brake comprising an electromagnet and a rotor composed of a ferromagnetic material, wherein a brake force is generated by eddy currents created in the rotor when it intersects the magnetic fluxes. A thin metal layer (30) consisting of three layers of nickel, copper and nickel is provided on the inner peripheral surface (15) of a cylindrical peripheral wall (11) of the rotor (10), and the outside of a coil (45) of the electromagnet (40) is surrounded by a magnetic pole casing (46) composed of a ferromagnetic material to obtain a large brake torque. The device is suited for use as an auxiliary brake for vehicles.



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SPECIFICATION

EDDY-CURRENT BRAKE

Field of Art

The present invention relates to an eddy-current braking system comprising a rotator having a three-layer thin metallic cladding on the surface which serves as a magnetic path and electromagnets arranged to increase the strength of magnetic field, wherein a large braking force is produced by the eddy current generated in said rotator.

Background Art

The conventional eddy-current brakes have the problem that the weight of the brake per braking torque produced is large in comparison with other types of brake. Generally, eddy-current brakes comprise a rorator made of a ferromagnetic material and electromagnets, which are arranged so that the rotator will intercept the magnetic flux, wherein a braking force is produced by the eddy current generated in the rotator. In such brakes, the smaller the electric resistance of the rotator material, the greater is the braking torque developed if the other conditions, namely electromagnet coil line diameter, number of turns of coil, electric current applied and space between electrode and rotator are the same. It is

an essential condition for such brakes that the rotator is made of a ferromagnetic material. Therefore, whatever magnetic material is used, there is produced no remarkable difference in the torque developed. This means that the eddy-current brakes are less suited for producing a large braking torque than the brakes of other systems. An invention which has improved this point and enabled the eddy-current brakes to develop a large braking torque is disclosed in PCT/JP87/00893 applied by the present inventor. The invention of PCT/JP87/00893 proposes the improvements in which the rotator surface opposing the electromagnet electrodes is clad with a metallic layer composed of a non-magnetic material having a greater electroconductivity than the rotator material to thereby increase the eddy current generated in the rotator while the coils of electro-magnets are enclosed by a magnetic pole case made of a ferromagnetic material, and each electromagnet is so designed that its sectional area through which the line of magnetic force of said magnetic pole case passes will be equal to or greater than the cross-sectional area of the magnetic pole so as to shorten the magnetic path of the electromagnet to thereby increase the strength of its magnetic field.

The present invention is intended to provide an eddy-current brake in which further improvements have

been made on the metallic layer to increase the eddy current generated in the rotator while enhancing the cooling performance of said metallic layer and also making it peel-resistant.

Summary of the Invention

The rotator surface opposing the electromagnet electrodes, where the line of magnetic force passes, is provided with an Ni-Cu-Ni three-layer thin metallic cladding. The electric resistance of the nickel (Ni) layer formed immediately on the rotator surface is 1/2 to 1/3 of that of iron (Fe), so that the eddy current generated in the rotator increases 2 to 3 times. The thermal expansivity of nickel is between those of copper (Cu) and iron (Fe). This proves helpful to minimize the relative displacement of the rotator and said metallic cladding due to rise of temperature caused by the eddy current, thus making said cladding proof against exfoliation. The electric resistivity of the copper (Cu) layer clad on the nickel layer is less than 1/10 of that of iron (Fe), which enables 10-fold increase of the eddy current generated in the rotator. The upper nickel (Ni) layer clad on the copper (Cu) layer serves to protect the copper (Cu) layer surface against oxidation when the rotator surface temperature has risen, thereby preventing lowering of heat transfer between said cladding and air due to formation of an oxide

film on the copper (Cu) layer surface. This enables maintenance of high cooling efficiency of the thin metallic cladding. It is thus possible to remarkably increase the braking torque produced in the rotator by properly selecting the thickness of the Ni-Cu-Ni three-layer thin metallic cladding.

Brief Description of the Drawings

FIG. 1 is a schematic sectional view of the eddy-current brake mechanism according to this invention.

FIG. 2 is an enlarged longitudinal sectional view of the metallic cladding.

FIG. 3 is an enlarged cross-sectional view of the metallic cladding.

FIG. 4 is a partial enlarged longitudinal sectional view of the rotator.

FIG. 5 is a sectional view of an electromagnet.

FIG. 6 is a drawing showing the arrangement of electromagnets.

Best Mode for Carrying out the Invention

Referring to FIG. 1, the rotator 10 consists of a cylindrical peripheral wall portion 11 extending concentrically with and parallel to the shaft 20 and an end wall portion 12 formed at one of the open ends of said peripheral wall portion 11 so that said end wall

portion 12 crosses said shaft 20 at right angles. This end wall portion 12 is provided at its center with a circular opening 13 and detachably secured thereat to a circular flange 21 adapted to be rotatable integrally with the shaft 20 so that the rotator 10 is rotable integrally with said shaft 20. Around the outer surface of said peripheral wall portion 11 are provided the thin-walled ring-shaped fins 14 at a substantially same pitch. These fins 14 are helpful for preventing rise of temperature of the rotator 10. Also, a thin metallic cladding 30 is provided over the entirely of the cylindrical inner surface of said peripheral wall portion 11. This metallic cladding 30, as shown in FIG. 2, consists of a 10 - 50 μÅ thick nickel (Ni) layer 31 formed immediately on the inner surface of the Fe-made peripheral wall portion 11, a 0.1 - 0.2 mm thick copper layer 32 formed on the surface of said nickel (Ni) layer 31 and a 40 - 60 μÅ thick nickel (Ni) layer 32 formed on the surface of said copper layer 32. This three-layer cladding can be formed by plating or welding.

FIG. 3 illustrates said three-layer metallic cladding 30 as it was applied to the inner surface of the peripheral wall portion 11 of the rotator 10. The substantially entirety of the inner surface 15 of said peripheral wall portion 11, saving an area of a small

length from the open end 16, is threaded to form triangular threads 17, and said Ni-Cu-Ni three-layer thin metallic cladding 30 is formed over the entirety of the inner surface 15 including said threads 17.

Electromagnets 40 are provided fixedly on the outer suface of a cylindrical fixing plate 41 secured concentrically with the rotator 20. Said fixing plate 41 has one of its cylindrical open ends secured to an immovable brake block 42 so that said fixing plate 41 itself won't rotate and also won't move easily. Said electromagnets 40 are arranged radially about the axis of said fixing plate 41, with two diametrically opposing magnets forming a pair. These electromagnets 40 are also so disposed that the top end face of the magnetic pole 43 of each electromagnet 40 will oppose the metallic cladding 30 of the rotator 10 with a slight space therebetween. Further, the coils 45 of said electromagnets 40 are enclosed by a magnetic pole case 46 made of a ferro-magnetic material. Said magnetic pole case 46 is so designed that its sectional area where the line of magnetic force passes will be equal to or greater than the cross-sectional area of the magnetic pole 43. As shown in FIG. 4, the cylindrical magnetic pole case 46 made of a ferro-magnetic material is formed integral with a flat bottom plate 44 so that said magnetic pole case 46 projects

in the axial direction from the outer edge of said bottom plate 44, and the magnetic pole 43 is formed at the center of said bottom plate 44. Coils 45 are provided on both sides of the magnetic pole 43. Preferably said magnetic pole case 46 is so formed that its size (sectional area) will be the smallest at its end contiguous to the bottom plate 44 and will gradually enlarge toward the top open end so that its sectional area will be the greatest at the top open end.

Industrial Utilizability

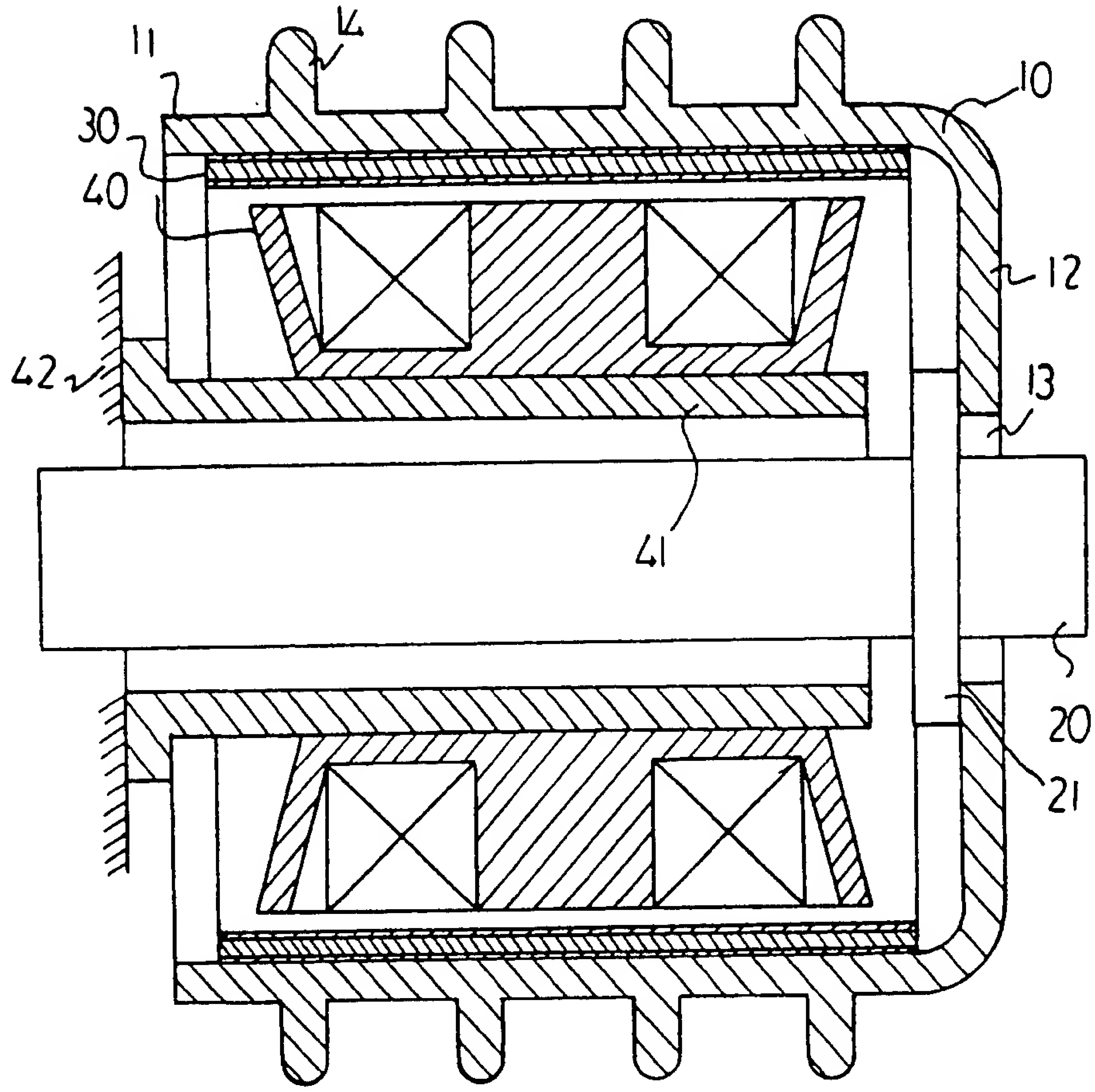
The eddy-current brake of this invention is suited for use as auxiliary brake unit for a main brake system in a vehicle.

WHAT IS CLAIMED IS:

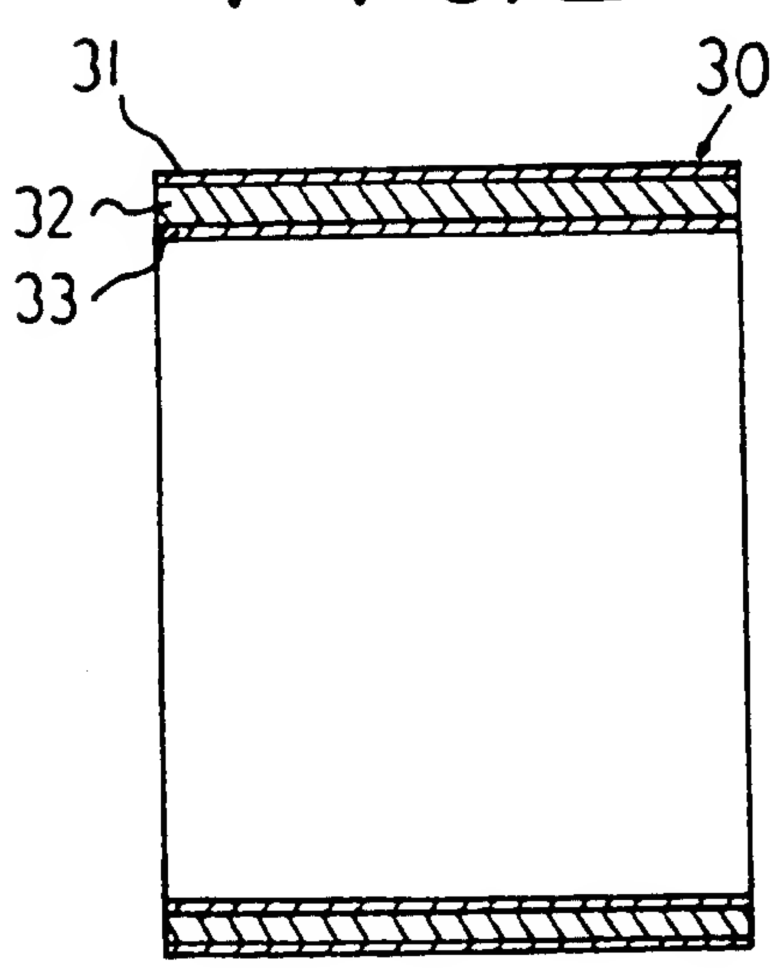
1. An eddy-current brake comprising a rotator and electromagnets arranged so that said rotator will intercept the magnetic flux, wherein a braking torque is produced by the eddy current generated in said rorator, said rotator having a peripheral wall portion extending parallel to and concentrically with the drive shaft and characterized in that an Ni-Cu-Ni three-layer thin metallic cladding is formed over the entirety of the inner surface of said peripheral wall portion.

2. The eddy-current brake according to claim 1, wherein of the three layers constituting said metallic cladding, the nickel layer formed immediately on the inner surface of the peripheral wall portion of the rotator is the smallest in thickness, the intermediate cupper layer is the largest in thickness, and the outer nickel layer is smaller than the cupper layer and equal to or greater than the first-said inner nickel layer in thickness.

F I G. 1



F I G. 2



F I G. 3

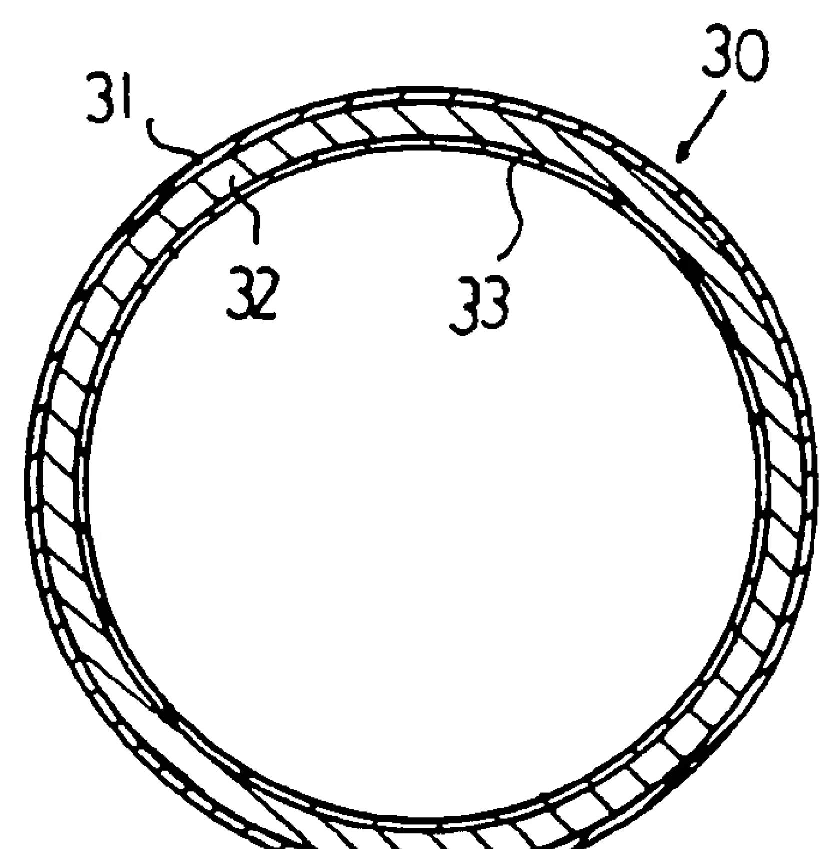


FIG.4

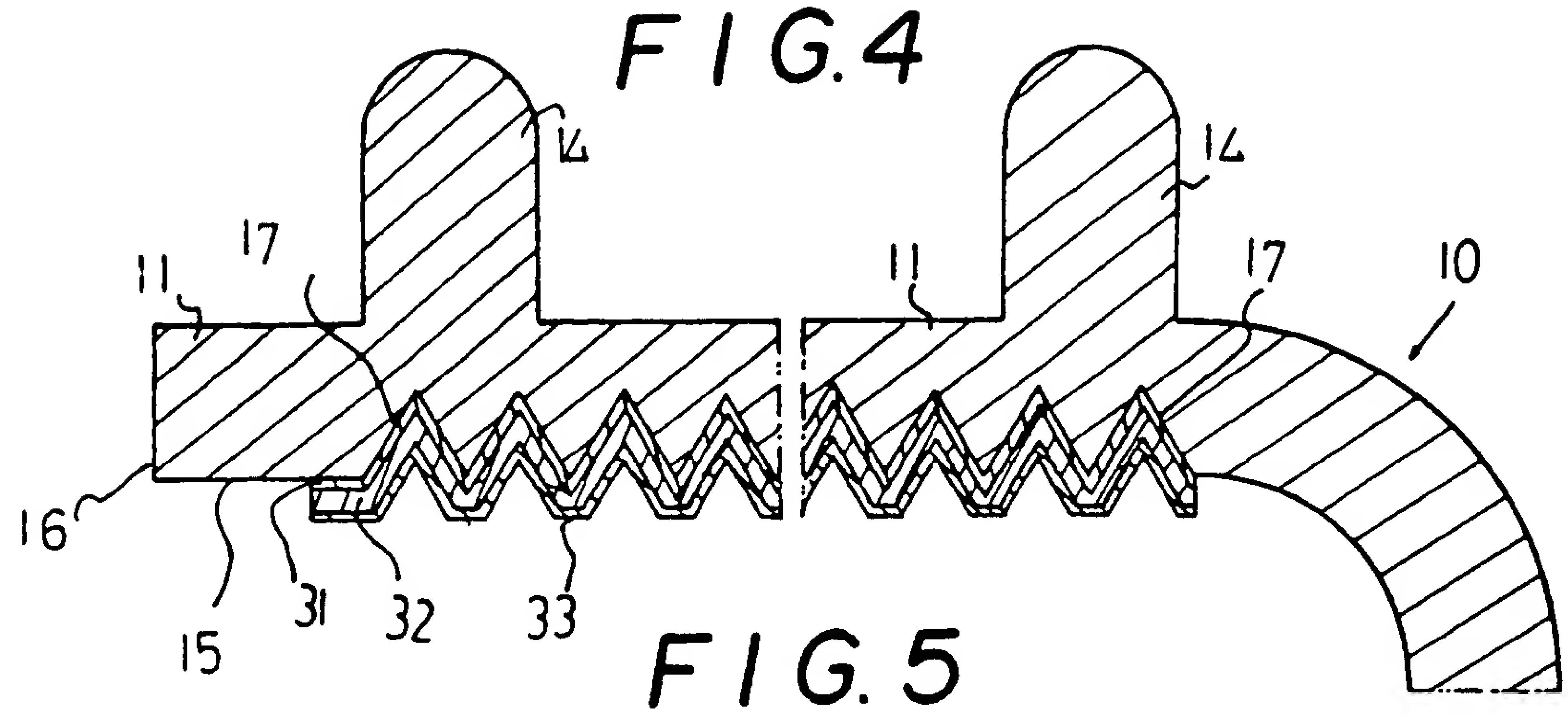


FIG.5

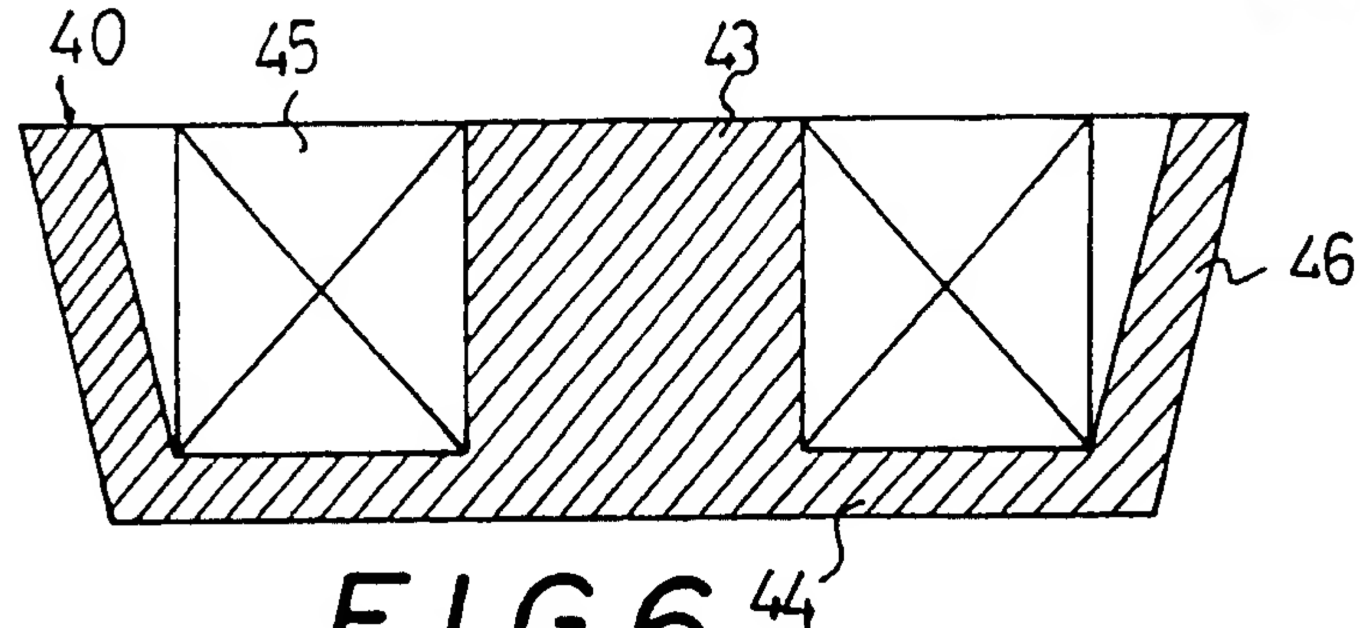
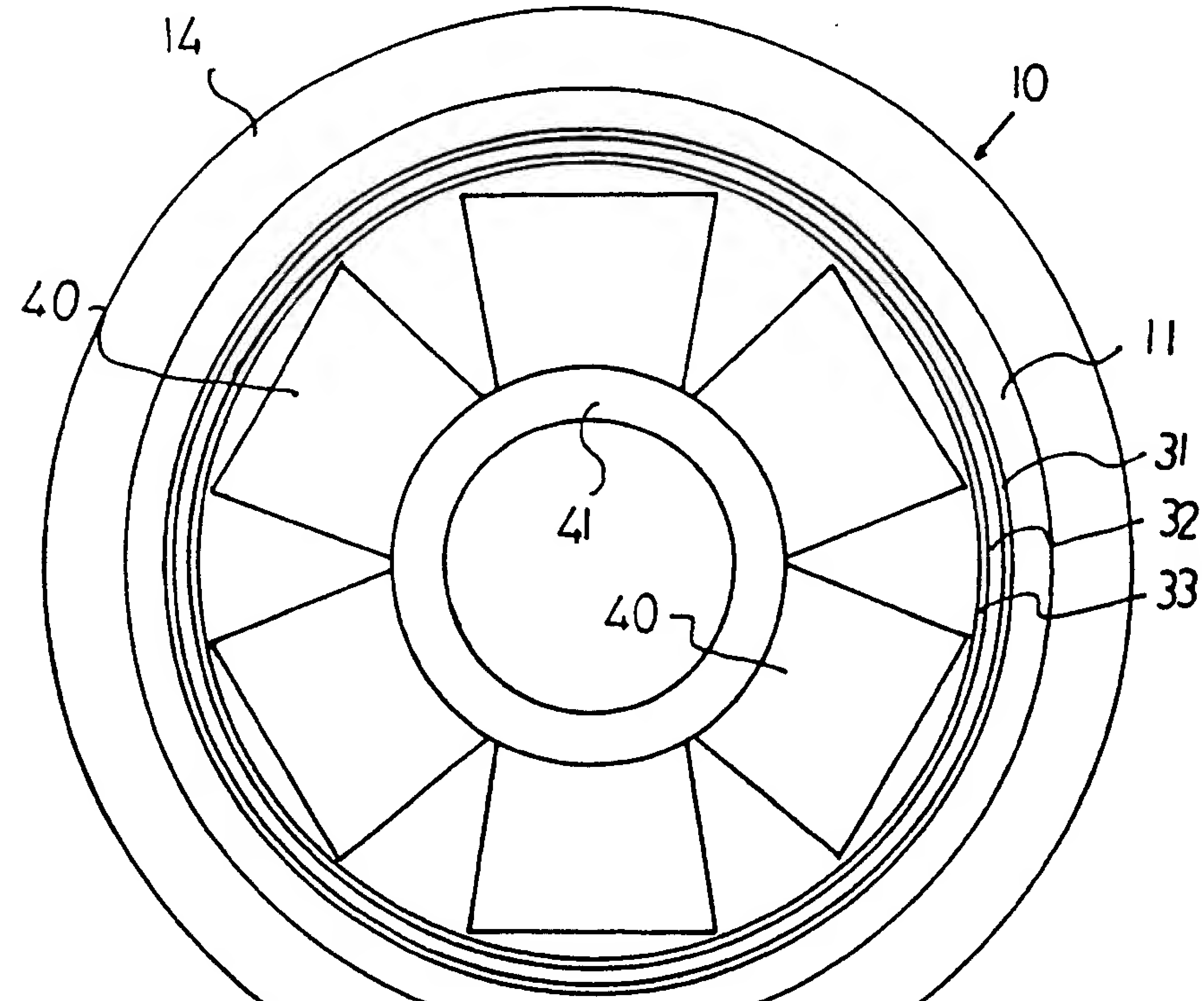


FIG.6



...TERNATIONAL SEARCH REPC 00312601

International Application No PCT/JP88/00346

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] H02K49/02

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	H02K49/00-49/12

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

Jitsuyo Shinan Koho	1932 - 1988
Kokai Jitsuyo Shinan Koho	1971 - 1988

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	JP, A, 48-27148 (Evan J. Davis) 10 April 1973 (10. 04. 73) & DE, A1, 2239668	1-2
A	JP, A, 56-133963 (Mitsubishi Electric Corporation) 20 October 1981 (20. 10. 81) (Family: none)	1-2
A	JP, A, 56-148170 (Sanyo Electric Co., Ltd.) 17 November 1981 (17. 11. 81) (Family: none)	1-2

* Special categories of cited documents:

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
June 23, 1988 (23. 06. 88)	July 11, 1988 (11. 07. 88)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	